The influence of study characteristics on coordinate-based fMRI meta-analyses.

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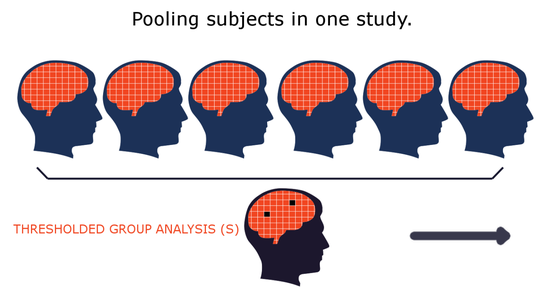
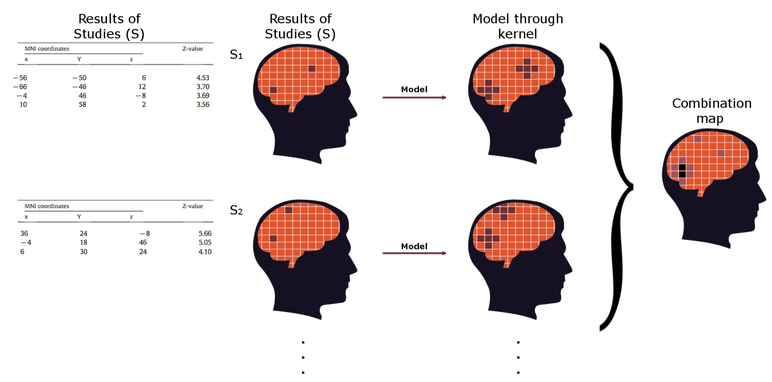
1. Coordinated-based meta-analyses

Coordinate based meta-analysis (CBMA) is a popular tool to integrate data across studies and labs. In this study we evaluate the **influence** of a study characteristic, i.e. the **group level analysis** model, on the **validity** and **test-retest reliability** of CBMA using a large data-set from the IMAGEN project [3].





2. Methods and outcome measures

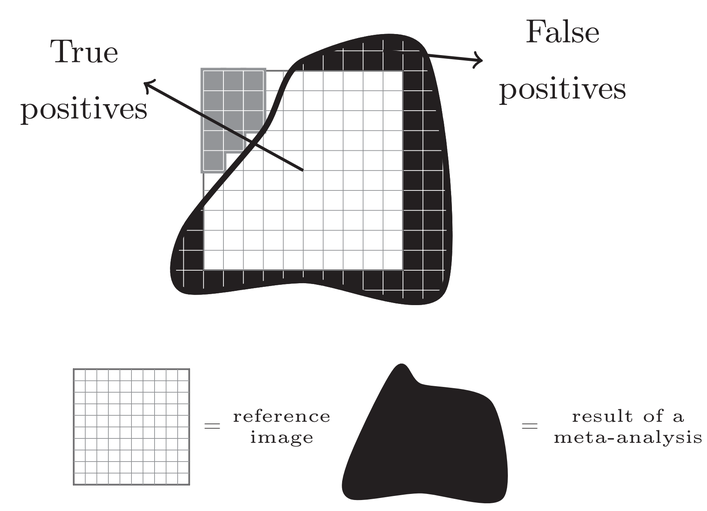
Group level analyses (FSL):

- fixed effects model
- ordinary least squares (OLS)
- mixed effects model

CBMA methods:

- **ALE** meta-analysis [1]: combines studies using only peak locations. Correction for multiple testing: *uncorrected*, *false discovery rate (FDR) -pID* (assumes independence or positivity in the joint distribution between voxels) and *FDR -pN* (no assumption on joint distribution).
- **seed based *d*-mapping** [2]: a random effects meta-analysis using not only peak locations but also peak height.
- **a fixed effects** analogue of seed based *d*-mapping.

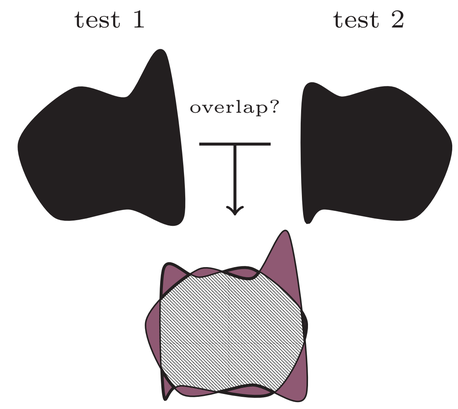
(1) Validity through ROC curves:



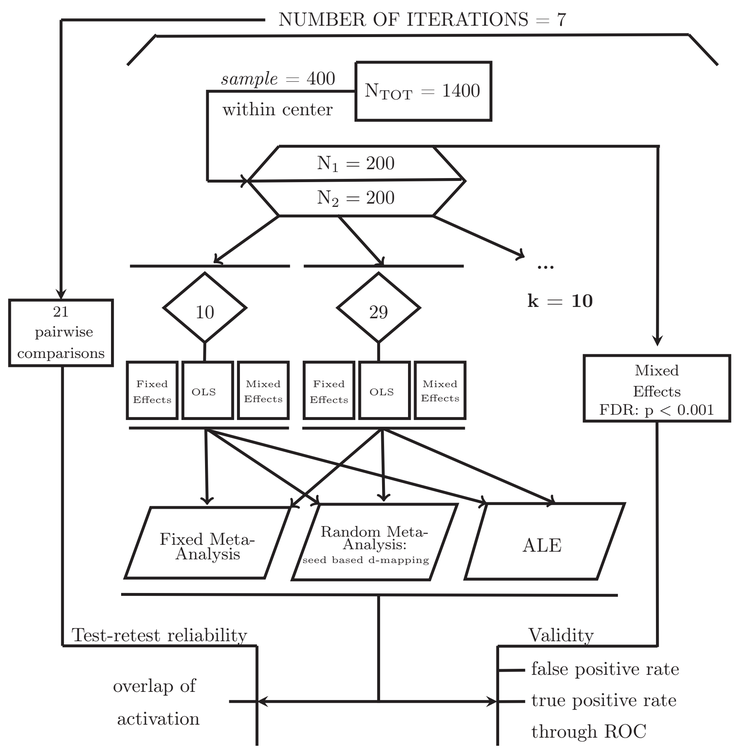
(2) Test-retest reliability (image i and j) using overlap of activation [4]:

$$\frac{V_{i,j}}{V_i + V_j - V_{i,j}}$$

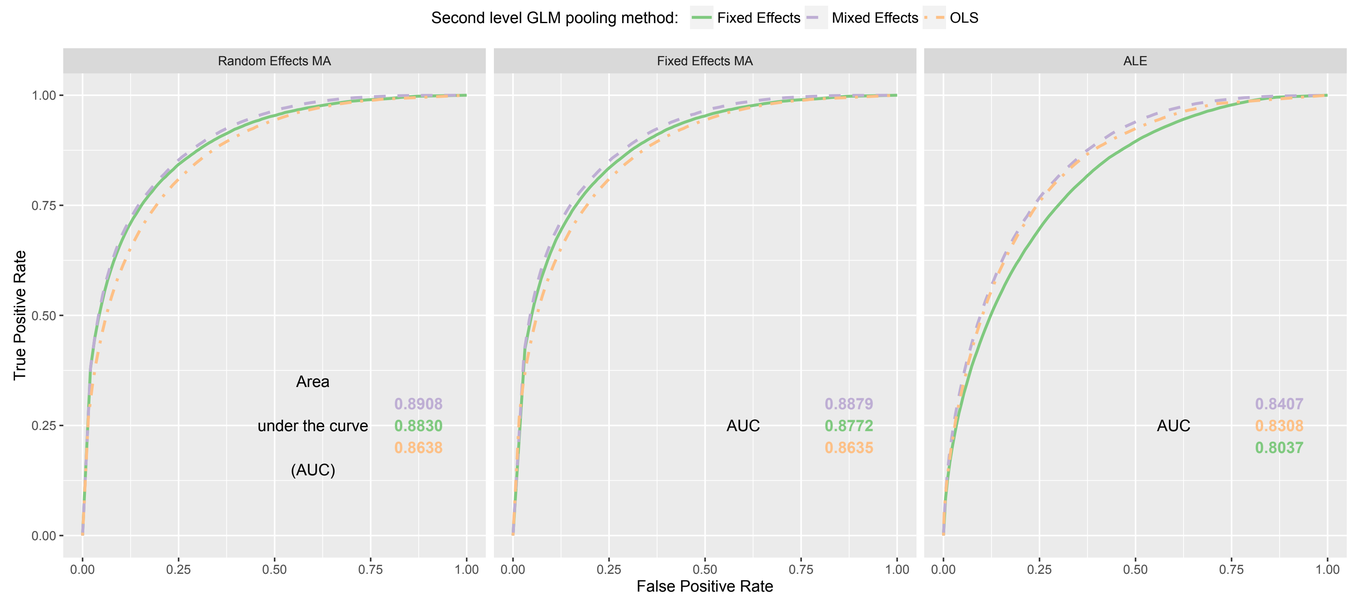
With $V_i(V_j) = \#$ voxels that are declared significant in image i (image j) and $V_{i,j} = \#$ voxels declared significant in both images.

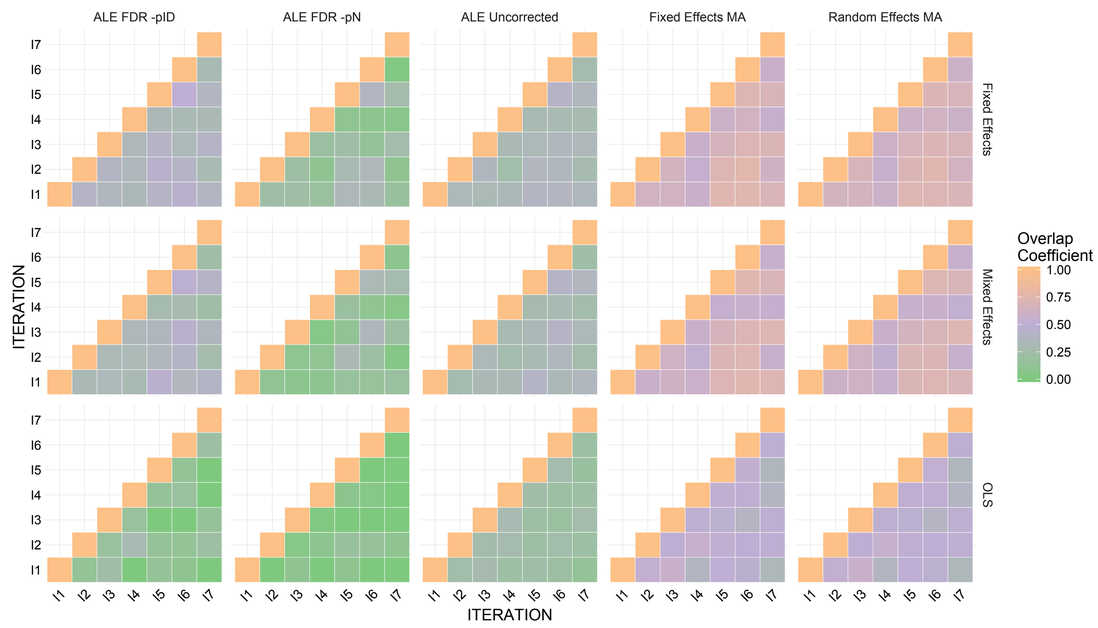


3. Design



4. Results: validity and test-retest reliability





5. Conclusion

Results show:

- highest AUC and test-retest reliability using random effects meta-analysis (MA) based on mixed effects pooling.
- lowest AUC using ALE on all pooling methods.
- lowest test-retest reliability using ALE after conservative multiple testing corrections (FDR -pN).

Hence we conclude that:

1. there is positive evidence in favor of **mixed effects pooling** methods at group level for all MA methods.
2. **random effects MA** using peak height outperforms other MA methods.

When between study heterogeneity would be larger, differences between fixed and random effects MA could be more apparent.

6. References

[1] Eickhoff S, et al. Coordinate-based activation likelihood estimation meta-analysis of neuroimaging data: a random-effects approach based on empirical estimates of spatial uncertainty. *Human brain mapping*, 30(9):2907–26, 2009.

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[3] Schumann G, et al. The imagen study: reinforcement-related behaviour in normal brain function and psychopathology. *Mol Psychiatry*, 15(12):1128–1139, 2010.

[4] R Maitra. A re-defined and generalized percent-overlap-of-activation measure for studies of fMRI reproducibility and its use in identifying outlier activation maps. *NeuroImage*, 50(1):124–35, 2010.

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